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(54) **Compositions**

(57) Compositions include a particulate filler such as pulverised fuel ash, cellulose fibres such as are obtained from waste paper, and optionally a cementitious binder such as Portland cement or gypsum.

An emulsifier such as a non-ionic surfactant may be added.

Numerous uses for the compositions as building blocks, cladding materials, plant growth media, modelling clay etc. are specified.

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SPECIFICATION

Compositions

- 5 This invention relates to compositions which find multifarious uses, e.g. in construction and/or insulating materials, and as plant growth media. 5
- The present invention provides a composition comprising a particulate filler, preferably a particulate inorganic filler, cellulose fibres, and, optionally a cementitious binder.
- 10 The compositions of the present invention are, in the presence of water, converted to formable plastic compositions which can be dried to structures of many different shapes and sizes. A composition in accordance with the present invention will usually include a cementitious binder when it is to be used in making construction materials. Such a composition, when set using water, hardens to a comparatively lightweight material of considerable strength. 10
- The compositions of the present invention preferably further include an emulsifier such as a surfactant, e.g. a nonionic surfactant. The compositions may include further additives as, for example, flame-retardants, 15 fungicides, insecticides, pigments, gravels, and sands. 15
- The preferred inorganic filler used in the compositions of the present invention is pulverized fuel ash, hereinafter referred to as P.F.A. This material is produced by coal-fired power stations in the form of a very fine powder, the P.F.A. particles being predominantly rounded. Its principal constituents are silica, alumina, 20 iron and calcium. P.F.A. may be obtained in the dry state, but as it is water-absorbent, it may also be obtained in the damp state. 20
- Instead of using P.F.A. in the compositions of the present invention, alternative powdered or granular fillers may be employed such as sea-sand, glass powder, powdered furnace bottom ash, powdered blast-furnace slag, micaceous wastes produced in the extraction of kaolin, saw-dust, slate-dust, and 25 refuse-waste. 25
- The preferred cellulose fibres used in the compositions of the present invention are those obtained in the form of waste pulp from paper mills. Such pulp contains cellulose fibres of less than paper-making length. However other cellulose fibres may be used, for example, cellulose fibres of paper-making length obtained by the pulping of waste paper such as newsprint. Such waste paper may contain kaolin which may act as a 30 binder. 30
- The cementitious binder used in the compositions of the present invention may be, for example, a Portland cement including ordinary and rapid-hardening Portland cements, a high-alumina cement, a gypsum cement, "Plaster of Paris", or even water-glass, depending on the properties required in the compositions when formed and set. Some cements, e.g. "Plaster of Paris" and gypsum cements, have rapid 35 setting properties, and may be used alone or in combination with Portland cement in desired ratios. A plasticiser, e.g. dibutyl phthalate, may be added. 35
- Gypsum cement is particularly preferred for use in those compositions which are to be used in making an insulating material for use in high temperature applications.
- The constituents may each be included in the compositions of the present invention in a wide range of 40 proportions by volume, e.g. about 5% to about 90% by volume of particulate inorganic filler, about 10% to about 95% by volume of cellulose fibres, 0% to about 90% by volume of cementitious binder, and 0% to about 10% by volume of emulsifier, depending on the end-use of the compositions. Normally, at least 20% of P.F.A. is used in the compositions of the present invention. 40
- As indicated above, the preferred inorganic filler is P.F.A. Depending on the efficiency of the power station 45 producing the P.F.A., the amount of silica and carbon therein will vary. The higher the proportion of silica, and the lower the carbon content of the P.F.A., the less cementitious binder will be required in relation to the P.F.A. for a given end-use. Accordingly, preferred P.F.A.'s contain as little as 4% carbon, or lower. Normally, more P.F.A. than cementitious binder is used in the compositions of the present invention. As little 50 cementitious binder and cellulose fibre as possible should be used in relation to P.F.A. or other filler in order to obtain the desired tensile strength or other properties. P.F.A. has been found to be very compatible with paper pulp. 50
- an emulsifying agent is preferably employed in the compositions of the present invention to obtain a mix of desired smoothness, consistency, and viscosity, thereby making the composition easier to work. Suitable emulsifying agents include surfactants as, for example, those nonionic surfactants sold under the Trade 55 Name "Lissapol NX" and "Synperonic NX". 55
- The applications for compositions of the present invention are multifarious but include, merely by way of example:- insulating and/or building slabs, boards or panels, building bricks, building blocks, paving blocks or slabs, external and internal building plaster, tiles including ceiling tiles, wall and roof cladding, infill for fire doors, modelling clay, loft insulating granules, garden furniture, lagging for tanks, cisterns, pipes, etc., 60 infill beads for flue linings, medical splints, ships's hulls, grouts, fillers, pipes and pipe-lines. All these can be reinforced using fibre-mesh or wire-mesh. 60
- Other structures, may be made from the compositions of the present inventions. For example, piping of any length can be made by cladding an inflated pneumatic tube with a formable wet composition of the present invention, allowing the cladding to dry, deflating the tube, and removing it from the formed piping. 65 Hollow roof-tiles may be snap-fitted together to provide a circuit for water which is heated by the sun's rays 65

to provide domestic warm water. The formable composition allows such accurate shaping as to permit water-tight snap-fitting together of the tiles.

Further, the present invention further provides a hollow building block having at least a partial vacuum therein, for use in building insulated structures. Such a building block may be produced by cladding a core block of foamed polystyrene with a formable composition of the present invention. After the composition has set, the block may be heated to a temperature e.g. about 800°C, to destroy the foamed polystyrene core and create the vacuum. Alternatively the polystyrene core can be destroyed by injecting sulphuric acid into the block using a non-return valve, removing the valve, and sealing the inlet hole. As a further alternative, the polystyrene core is not used, but a hollow block is fashioned, the air is withdrawn through an outlet hole using a suction pump, and the hole is then sealed. Such blocks have very good heat and sound insulating qualities. Further, such blocks may be painted with, for example, a thermoplastics-based paint, to assist in ensuring a hermetic seal. When used for building, the blocks can be arranged in overlapping manner in order to maximise the insulating effect.

As indicated above, the compositions of the present invention set in the presence of water. The P.F.A. and cellulose fibres used in the compositions normally contain water and indeed may contain sufficient water to set the compositions without the addition of further water. Further water may be added as and if necessary. Accordingly, P.F.A. and waste paper pulp are not normally mixed with the cementitious binder until the formable compositions are required for use. In accordance with one embodiment of the present invention, waste paper pulp and P.F.A. are mixed together, preferably with an emulsifier, and stored in the damp state in a waterproof, e.g. plastics, bag. The required amount of cementitious binder, such as Portland cement, is sealed within a separate waterproof, e.g. plastics, bag, which bag may itself be sealed within the first-mentioned bag.

According to an important aspect of the present invention, compositions in accordance therewith but excluding a cementitious binder are used as plant growth media.

Some preferred embodiments of the present invention will now be described by way of example. In the Examples hereinafter, the P.F.A. used contained about 4% water, unless otherwise indicated. The waste paper pulp consisted of cellulose fibres of less than paper-making length and contained about 13 to 15% water. In the manufacture, the water contained in the cellulose fibres can be taken up by using a neat emulsifier. The emulsifier used was "Lissapoi NX" emulsifier. All percentages quoted are by volume.

Example 1

The following are thoroughly mixed together in a suitable mixer in the amounts stated:-

	P.F.A.	20%	
35	Waste paper pulp	60%	
	(Dry) Portland Cement	18%	
	(Dry) Plaster of Paris	1%	
	Emulsifier	1%	

The mixture contains sufficient water to produce a good set without any necessity to add further water. This composition is very useful for internal or external plastering, and may be applied in conventional manner.

Example 2

Building bricks may be prepared on site or in a brickworks using the following formulation:-

	P.F.A.	30%	
	Waste paper pulp	42%	
	Portland Cement	25%	
50	Emulsifier	3%	

The components are thoroughly mixed in a mixer, the mix is poured into moulds and allowed to set.

Example 3

Insulating panels are prepared using the following formulation:-

	P.F.A.	40%	
	Waste paper pulp	45%	
	Portland Cement	10%	
60	Emulsifier	5%	

After thorough mixing, the mix is poured into a suitable mould and allowed to set. Paints, e.g. thermoplastics-based paints, "key" particularly well to the surface of the insulating board, and provide a very smooth surface which can be readily cleaned, e.g. by steam. Such panels find particular use in situations where high standards of hygiene are required, e.g. in hospitals and abattoirs.

A suitable thermoplastics-based paint comprises waste polycarbonate and/or polystyrene dissolved in a hydrocarbon solvent, e.g. xylene and/or naphtha. Preferably the paint includes an emulsifier such as aluminium stearate, a plasticiser such as dibutyl phthalate, and pigments such as kaolin or titania. P.F.A. may also be included in the paint formulation if desired. The ingredients may be fed through a high-speed shear-head machine to provide the finished paint.

Example 4

Heat insulating granules or beads are prepared from the following formulation:-

10	(Dry) P.F.A.	5%	10
	Waste paper pulp	90%	
	Portland Cement	5%	

The pulp is placed in a ball mill and, when the mill is operating, the cement and dry P.F.A. are added. The pulp picks up the cement and P.F.A. to form granules or beads. No water need be added as sufficient is present in the pulp.

After setting, these granules or beads are of particular use for loft insulation, and as in-fill for cavity walls and flue linings.

Example 5

Acoustic tiles are prepared from the following formulation:-

	P.F.A.	20%	
	Waste paper pulp	60%	
25	Gypsum Cement	18%	25
	Emulsifier	2%	

After thorough mixing, the mix is poured into moulds. When set, the tiles are painted with the thermoplastics-based paint described above.

Example 6

A ring-shaped life-saver is moulded from the following formulation:-

	P.F.A.	10%	
35	Waste paper pulp	75%	35
	Portland Cement	10%	
	Emulsifier	5%	

The components are mixed for 30 minutes in a paddle mixer (or "dough machine") before moulding to shape. After setting, the ring is painted with the thermoplastics-based paint described above. The life-saver floats without becoming water-logged. It is light in weight, strong, and durable.

Instead of using Portland cement in the formulations given in the above Examples, other cementitious binders such as gypsum cements may be used.

Gypsum cements, e.g. those sold under the Trade Names "Thistle" and Serafite, render the compositions of the present invention more resistant to high temperatures, and are preferably used in those applications requiring such resistance as in the lagging of high temperature pipes.

Example 7

Insulating board was produced from the following formulation:-

50	P.F.A.	40%	50
	Waste paper pulp	59%	
	Emulsifier	1%	

The wet formulation is mixed for about 20 minutes and laid into a mould of the desired shape and size. After setting, the board is painted with the above-described thermoplastics-based paint which keys particularly well to the board. The board can be nailed, screwed, or otherwise secured to existing structures, and can be sawn to shape if desired. The board has good acoustic properties.

Example 8

Loft-flakes for use in insulating lofts is made from the following formulation:-

	P.F.A.	7%	
	Waste paper pulp	90%	
65	Emulsifier	3%	65

Flakes are produced from the wet mix in conventional manner.

Example 9

Modelling clay is produced from the following formulation:-

5	P.F.A.	15%	5
	Waste paper pulp	75%	
	Emulsifier	10%	

10 This mix can be thrown like pottery clay, and sets to a hard material. The formulation may include pigments of various colours. When set, the material will readily accept paints, including metallic paints. 10

Example 10

The following formulation namely

15	P.F.A.	10%	15
	Waste paper pulp	20%	
	Borax	5%	
	Water	60%	
20	Foaming agent	5%	20

was mixed, and pumped through an airless spray onto interior walls and interior roof-spaces.

Where appropriate, a flame retardant may be included in the Examples given above.

As already indicated above, one important aspect of the present invention is the provision of a plant growth medium comprising an inorganic filler material, preferably P.F.A., and cellulose fibres, preferably waste paper pulp in which the fibres are of less than paper-making length. 25

P.F.A. contains plant nutrients, e.g. potash, whereas many other particulate inorganic fillers do not. When, in accordance with the present invention, such other fillers are used, plant nutrients must be added to the formulation.

30 Preferably no, or as little emulsifier as possible, is used in the formulation of the plant growth medium. As little cellulosic fibre as possible should be used to avoid over-handening of the plant growth medium when laid. For example, a suitable formulation comprises 75% by volume P.F.A., and 15% by volume waste paper pulp in which the cellulosic fibres are of less than paper-making length. The remainder of the formulation is comprised by, for example, fertilisers, weedkillers, fungicides, and insecticides. The components of the formulation may simply be mixed together using a pan or mortar mixer. 35

If desired, in making up the formulation, dry P.F.A. and paper pulp is used, and a solution in water of the other ingredients, including plant nutrients, is added prior to thorough mixing. A preferred emulsifier, if used, is a biodegradable emulsifier such as "Symperonic BD 95".

The formulation may be applied as a wet mix to the grounds, e.g. to spoil tips, where it dries out to a soil-like nature. Unlike P.F.A. alone, it will not readily dry out and blow away, and can be used for growing crops, although it is preferably used for grassing spoil tips. 40

Plant seed, especially grass seeds, may be included in the formulation, and as the wet mix can be laid perfectly flat, a good flat lawn can be produced. Moreover, the wet mix can be sprayed onto spoil tips and sand-hills, to assist in stabilising the ground.

45 Alternatively, plant pots or blocks for use can be made out of the formulation. Seeds may be planted in such plant pots or blocks, and seedlings allowed to develop before the plant pots or blocks are implanted in soil. 45

CLAIMS (Filed on 31.3.83)

- 50 1. A composition comprising a particulate filler, preferably a particulate inorganic filler, cellulose fibres, and, optionally a cementitious binder. 50
2. A composition according to claim 1 which, in the presence of water, is converted to a formable plastic composition which can be dried to structures of many different shapes and sizes.
- 55 3. A composition in accordance with claim 1 or 2 including said cementitious binder, when used in making construction materials. 55
4. A composition according to any preceding claims and including an emulsifier.
5. A composition according to claim 4 in which the emulsifier is a nonionic surfactant.
6. A composition according to any preceding claim including further additives comprising one or more of the following:- a fungicide, an insecticide, a pigment, gravel or sand. 60
7. A composition according to any preceding claim in which the inorganic filler is pulverised fuel ash.
8. A composition according to any of claims 1 to 6 in which the inorganic filler is a powdered or granular filler selected from sea-sand, glass powder, powdered furnace bottom ash, powdered blast-furnace slag, micaceous wastes produced in the extraction of kaolin, saw-dust, slate-dust, and refuse-waste.
- 65 9. A composition according to any preceding claim and in which the cellulose fibres are in the form of 65

waste pulp from paper mills, or waste paper obtained from pulping of waste paper such as newsprint.

10. A composition according to claim 9 in which the paper contains kaolin which acts as a binder.

11. A composition according to any preceding claim in which the cementitious binder is selected from a Portland cement including ordinary and rapid-hardening Portland cements, a high-alumina cement, a gypsum cement, "Plaster of Paris", or even water-glass, depending on the properties required in the compositions when formed and set.

12. A composition according to any of claims 1 to 10 in which the cementitious binder is "Plaster of Paris" or gypsum cement, having rapid setting properties, used alone or in combination with Portland cement.

13. A composition according to any preceding claim including a plasticiser such as dibutyl phthalate.

14. A composition according to any of claims 1 to 10 in which the cementitious binder is gypsum cement and the composition is employed in making an insulating material for use in high temperature applications.

15. A composition according to any preceding claim including 5% to 90% by volume of particulate inorganic filler, 10% to about 95% by volume of cellulose fibres, 0% to 90% by volume of cementitious binder, and 0% to 10% by volume of emulsifier, depending on the end-use of the compositions.

16. A composition according to any preceding claim including at least 20% of pulverised fuel ash.

17. A composition according to claim 16 in which the pulverised fuel ash contains up to 4% carbon.

18. A composition according to any preceding claim reinforced with fibre-mesh or wire mesh.

19. A composition according to any preceding claim when used as any of the following items:- insulating and/or building slabs, boards or panels, building bricks, building blocks, paving blocks or slabs, external and internal building plaster, tiles including ceiling tiles, wall and roof cladding, infill for fire doors, modelling clay, loft insulating granules, garden furniture, lagging for tanks, cisterns, pipes etc., infill beads for flue linings, medical splints, ship's hulls, grouts, fillers, pipes and pipe-lines.

20. Piping of any length made by cladding an inflated pneumatic tube with a formable wet composition according to any preceding claim, allowing the cladding to dry, deflating the tube, and removing it from the formed piping.

21. A hollow building block having at least a partial vacuum therein, for use in building insulated structures, produced by cladding a core block of foamed polystyrene with a formable composition according to any preceding claim.

22. A building block according to claim 21 which is heated to a temperature high enough to destroy the foamed polystyrene core and create the vacuum.

23. A building block according to claim 21 in which the polystyrene core is destroyed by injecting sulphuric acid into the block using a non-return valve, removing the valve, and sealing the inlet hole.

24. Compositions in accordance with any preceding claim, but excluding a cementitious binder, when used as plant growth media.

25. Compositions substantially as hereinbefore particularly described and as illustrated in the accompanying drawings.